Technical Note DOER-N3
March 1998

Planning Considerations for Nearshore Placement of Mixed Dredged Sediments

PURPOSE: Dredging planning and management decisions are based on a combination of engineering and economic factors tempered by environmental considerations. The purpose of this technical note is to address primary considerations (although not all-inclusive) for planning and managing nearshore placement of mixed sediment from dredging projects.

BACKGROUND: As part of its ongoing navigation channel maintenance mission, the U.S. Army Corps of Engineers (USACE) dredges large amounts of noncontaminated sand/silt mixtures, which are then available for beneficial nearshore placement. Often this material is excluded from nearshore placement consideration because of unknowns related to regulatory concerns about the ultimate fate of fines: will the fines move onto the beach; is water quality negatively impacted; and what, if any, impact is there to environmental and economic resources like fisheries and oyster beds?

Typically, USACE alternatives for disposing of mixed dredged sediments are limited by State and local regulatory requirements that restrict the percentage of fines (usually less than 20 per- cent) allowed to be placed directly on the beach. Beach placement of material containing large quantities of fines is undesirable because of the environmental impact that the smaller grain size (may cause the beach face to harden) and/or darker color (increases beach temperature, thus affecting sea turtle nesting and/or aesthetic appeal) may have on the beach and beach habitat.

Little is known about the impact of placing sediments with larger relative percentages of fines in the nearshore. Because knowledge of the behavior of mixed sediments placed in the nearshore is limited, USACE has as its only alternatives offshore disposal or upland placement for mixed dredged sediments. This activity not only keeps much-needed sand resources from the local littoral zone, but it can also be more expensive and time-consuming than nearby placement (i.e., nearshore).

Research on nearshore placement of mixed sediments is currently being conducted under the Dredging Operations and Environmental Research (DOER) Program at the U.S. Army Engineer Waterways Experiment Station (WES). One of the DOER focus areas, Dredged Material Nearshore and Offshore Placement, is investigating how fine- and coarse-grained sediments behave together and independently when placed in the nearshore as a mixed sediment. Results of this research will lead to tools that will assist planning, engineering, and operations personnel in (a) predicting the ability of a mixed-sediment placement to enhance the nearshore region, (b) assessing physical and environmental benefits/impacts, and (c) justifying USACE projects, promoting cost-sharing, and addressing regulatory agency concerns.

NEARSHORE PLACEMENT PURPOSE: The primary purpose for nearshore placement of dredged material is to reduce overall navigation maintenance costs. Navigation channel maintenance dredging can, for illustration purposes, be separated into dredging and disposal costs,

the latter of which is the focus of this technical note. Much of the cost of disposal is a function of time (e.g., time for a hopper dredge to transit to/from an offshore disposal site). The farther a hopper dredge has to travel during the dredge cycle, the more fuel that is consumed, and the longer it takes to dredge a project. Nearshore placement of mixed dredged material, in many cases, would reduce transit times for hopper dredges and possibly reduce pumping distance for some pipeline dredges, both of which would result in reduced costs.

In addition, nearshore placement has applications as a beneficial use approach, as material that traditionally is placed offshore and lost to the local littoral zone now would be kept nearby and possibly enhance nearshore profiles and/or beaches. Nearshore placement could also offer a link between the often independent channel dredging activities and beneficial use (e.g., beach nourishment) activities. By linking these activities, interactive project design is facilitated, and both navigation and beach use interests can collectively identify a least-cost dredging and nearshore placement solution benefitting all parties. Potential benefits from nearshore placement of mixed sediments are provided in the adjacent table.

Potential Nearshore Placement Benefits
Supplements beach profile by adding material to the littoral zone
Renourishes beach
Decreases nearshore wave heights, thereby reducing damage from erosive waves and storms
Provides fisheries habitat
Reduces use of limited-capacity upland and offshore disposal sites
Decreases mobilization/demobilization costs
Shortens haul distance for hopper dredges and shorter pumping distance for pipeline dredges

NEARSHORE PLACEMENT OBJECTIVE: Initially, planners and designers must decide on the objective of the nearshore placement. Objectives of nearshore placement of dredged material vary from simply placing the material in the littoral zone to "feed" the littoral system to designing and constructing a nearshore berm feature that attenuates waves or serves as a habitat.

Commonly, nearshore placement involves design and construction of a nearshore berm or mound. Typically, finer grained sediments (which are less desirable on beaches) placed with hopper dredges or barges (from clamshell/bucket dredges) are used to construct "stable" berms in deeper water. If the berm relief is sufficiently tall compared with the water depth and local wave climate, stable berms can reduce wave energy on their lee. For "feeder" berms, material more closely resembling native sands is used to match local beach sand and/or nearshore sand. Nearshore placement (in the form of berms) can also serve as fish habitat. Design guidance of nearshore berms was developed under the WES Dredging Research Program (DRP) and is provided in McLellan (1990a, b), Burke and Allison (1992), and Pollock and Allison (1993). For illustration, an analytical study (using the DRP guidance) was conducted to determine the economic feasibility of a nearshore berm alternative for the St. Johns County, Florida, Beach Erosion Control Project. This effort is described in Pollock, Curtis, and Moritz (in preparation).

In some cases, a designed "berm" may not be desired or cannot be constructed with available material. However, nearshore placement may keep material in the local littoral zone to facilitate marsh creation (or slow marsh degradation) or act sacrificially in lieu of nearby beaches or marshes. By way of example, the U.S. Army Engineer District, New Orleans, pumped fine-grained sands

and silts from the Mississippi River-Gulf Outlet Navigation Channel to the nearshore of Breton Island to create a sacrificial feature approximately 7 ft high in 15 ft of water that persisted for 2 years (Williams and Mathies 1996). Figures 1 and 2 illustrate a nearshore feature as viewed from overhead and in cross section, respectively, demonstrating the likely movement of sand into the littoral system or onto the beach and fines moving offshore.

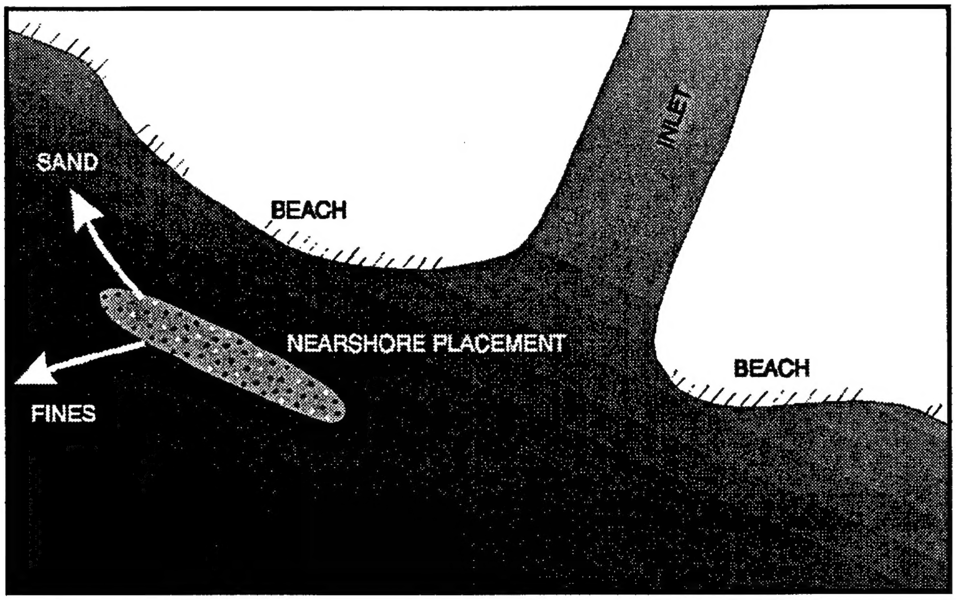

Figure 1. Illustration of nearshore placement (overhead view)

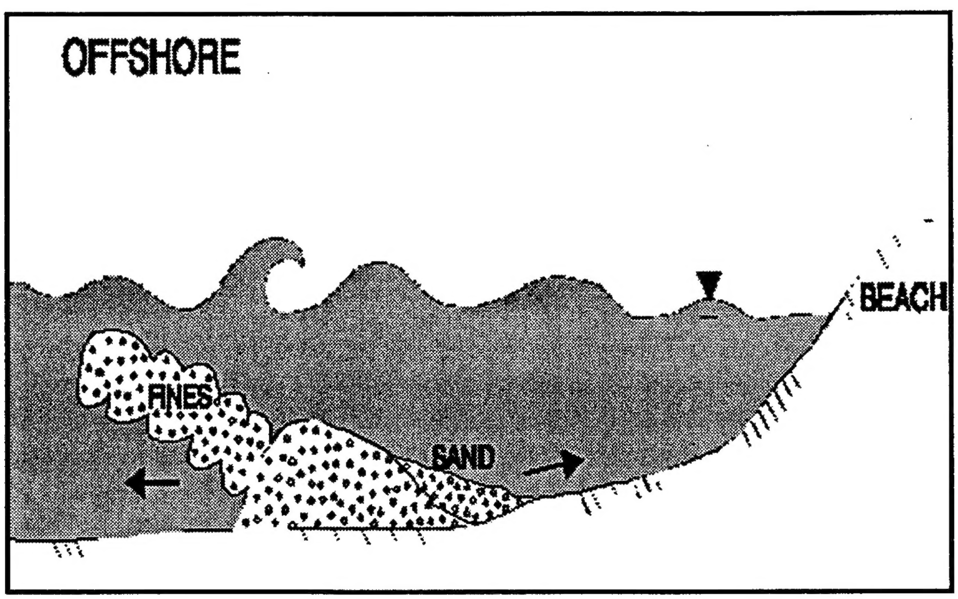

Figure 2. Illustration of nearshore placement cross section

DREDGING AND PLACEMENT ALTERNATIVES: The selected purpose for nearshore placement will to a large extent suggest the dredging and placement method used. In general, dredging can be conducted either mechanically (clamshell, bucket, or dipper dredge) or hydraulically (plain suction, cutterhead, hopper dredge). Usually, mechanically dredged material is placed in a bottom-release scow from which it is discharged into the water column to settle to the seafloor. Material (particularly fine-grained) dredged by this method tends to maintain bulk densities at or near those of in situ conditions, which contributes to a more cohesive mound or feature at the placement site. Mechanically dredged coarse-grained material (sands) also maintains high bulk densities, but is more likely to lose coherence during descent through the water column. Generally, however, mechanically dredged material, whether fine- or coarse-grained, is more conducive to forming a lasting berm.

Hydraulic dredging involves fluidizing sediments for pumping. Hopper dredges fluidize bottom sediments for pumping into their hoppers, which significantly reduces bulk density from in situ. However, once in the hopper, sediment bulk density increases, though usually not to the predredging levels. Hopper dredges discharge material through doors or a split hull from which the dredged material settles to the bottom in much the same way as from a bottom-release barge or scow. When released, the fluidized material is more susceptible to dispersion during descent through the water column. Depending on the type of dredged material, however, densities that are nearly in situ can be realized to create more stable features. Hydraulic pipeline dredges (cutterhead and plain suction) fluidize material throughout the dredging and transport phases. Usually, pipeline-dredged material is discharged to a confined disposal facility for drying and consolidation. In some cases, pipeline dredges discharge directly into the water column, and evidence has shown that a feature can be created with relatively fine-grained material using a pipeline dredge (Williams and Mathies 1996).

PLACEMENT SITE FACTORS: Many factors relating to mound or feature geometry should be considered for nearshore placement of dredged material. Placement site geometry depends on a wide range of factors including the placement objective, type and volume of material to be placed, dredging and placement methods, environmental restrictions (areal and material composition), existing profile, and restrictions on feature relief (from boating and navigation interests).

In situ sediments at the dredging site must be characterized to determine type of material and if it is contaminated. Bathymetry of the proposed placement site defines the placement site location and boundaries, and knowledge of the hydrodynamic climate (wind, waves, and currents) is necessary to assess the potential physical behavior of dredged sediment and to properly site a mound or berm to optimize stability, wave breaking, or nearshore/beach feeding benefits. In addition, assessment of benefits and risks to submerged coastal habitats for shellfish, fisheries resources, and endangered species is necessary to determine short- and long-term environmental impacts.

ECONOMIC CONSIDERATIONS: Economic considerations for nearshore placement of dredged material are primarily related to the type of dredging equipment used and placement/discharge method and location. Dredging costs are typically divided into two primary elements: mobilization/demobilization (mob/demob) and unit cost. Mechanical and pipeline dredges have relatively higher mob/demob costs because those dredges require tugs to move, support vessels to transport pipe or barges, and in some cases, land-based equipment for reworking of the placed dredged material. Hopper dredges placing dredged material in open water typically have lower

mob/demob costs because a hopper dredge is an oceangoing vessel requiring less support. However, if a hopper dredge is placing material via a direct pump-out buoy, mob/demob costs could be comparable with mechanical and pipeline dredges.

Hopper dredges placing material nearshore by bottom discharge can help minimize overall dredging project costs in two ways: (a) the lower mob/demob cost becomes more attractive (relative to other dredge types); and (b) shorter haul distance to the nearshore placement site saves time and fuel costs. Pipeline dredges can also reduce overall dredging project costs by placing material nearshore. A pipeline dredge discharging into the nearshore reduces its own mob/demob costs by eliminating those factors associated with land-based equipment, and the shorter pumping distance reduces operating time and fuel consumption.

Limitations that must be considered are that some hopper dredges may be unable to access desired shallow-water placement sites because of draft limitations. Alternatives include "light-loading," which reduces the vessel draft, and speciality shallow-draft hopper dredges. Pipeline discharging into the nearshore may also be limited because of the more energetic hydrodynamic environment closer to shore, which can create large forces on the pipeline.

Ultimately, projects considering nearshore placement of dredged material must optimize costs by closely examining the dredging requirement, cost of available equipment specific to the project of interest, type of nearshore feature desired, and volume of material to be dredged. In some cases, the benefitting parties may have to contribute larger portions of the dredging and placement costs to ensure that the desired feature is constructed with appropriate equipment if the selected equipment or method is more expensive than the least-cost method.

SUMMARY: Planning and designing a dredging project with nearshore placement alternatives first require knowledge of the physical and ecological environment. Engineering decisions can then be made to determine potential placement alternatives that, in turn, provide a basis for decisions driven by economic factors. The results of such decisions may provide a beneficial, economically feasible nearshore placement alternative.

Under the DOER Program, investigations will be conducted in the Evaluation and Design of Nearshore Placement of Mixed Sediments Work Unit to enhance opportunities for nearshore placement of mixed sediments. Additionally, other work units in the Nearshore and Offshore Placement Focus Area will include physical model investigations of mixed sediment movement, improvement of existing numerical models determining the fate of dredged material, and environmental effects of material placed in the nearshore. Benefits from this research will include improved use of maintenance dredged material for shoreline stabilization, increased acceptance by regulatory agencies of nearshore placement as a viable long-term disposal alternative, and lower costs for overall maintenance dredging operations.

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> U.S. Army Engineer Waterways Experiment Station. (1998). "Considerations for planning nearshore placement of mixed dredged sediments," Technical Note DOER-N3, Vicksburg, MS.

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